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MICROEDGED SHAVING SURFACE AND A METHOD FOR MAKING THE SAME

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Cross-Reference to Related Applications

[0001] This application is entitled to the benefit of and incorporates by reference essential subject matter disclosed in Provisional Patent Application No. 60/446,292 filed on February 10, 2003.

Field of the Invention

[0002] The present invention is generally related to shaving implements, and is more particularly directed to a shaving surface defined by a plurality of discrete shaving elements and a method for making the shaving surface.

Background of the Invention

[0003] Historically, razors used for the removal of hair from skin employed one or more blades having longitudinally sharpened edges. These blades have a tendency to cut the user's skin and to otherwise cause discomfort during a shaving operation. In an effort to minimize the danger related to the exposed cutting edges of these razors, guards have been incorporated into the razor design. The guard is generally interposed between the user's skin and the cutting edge of the razor blade. This allows the cutting edge of the blade to pass over a user's skin and cut hair extending outwardly therefrom while minimizing the potential for nicks and cuts. However, this modification affects the closeness of the shave, and is not entirely effective in preventing injury to the user.

[0004] Blade structures incorporating multiple apertures each having a sharpened edge have also been disclosed in the prior art. However, experience has shown that the expense associated with manufacturing blades of this type is, at present, prohibitive.

[0005] Based on the foregoing, it is the general object of the present invention to provide a shaving surface that overcomes the problems and drawbacks of the prior art.

Summary of the Invention

[0006] The present invention is directed in a first aspect to a method for making a microedged shaving surface wherein a substrate has a layer of polymer applied over at least a surface thereof. An edge layer of material is deposited over the polymer layer and has hardness sufficient to support a cutting edge. The edge layer is coated with a photoresist material which is then cured to render selected areal portions thereof, substantially impervious to removal by etching. Once cured, those areal portions of the photoresist material adjacent to the substantially impervious areas are processed so that a plurality of reentrant profiles are created in the polymeric material. The remaining photoresist material is then stripped away, and the edge layer is etched to expose a plurality of discrete shaving elements, each defining a peripheral edge having sharpness sufficient to cut into human hair. The substrate around the discrete shaving elements is then exposed so that the cutting edges are offset from the substrate.

[0007] In the preferred embodiment of the present invention, the edge layer is tungsten with a layer of copper located over the tungsten. In addition, the photoresist material comprises a negative resist. However, the present invention is not limited in this regard as a positive resist can also be employed without departing from the broader aspects of the present invention.

[0008] The present invention also resides in a second aspect in a microedged-shaving surface wherein a substrate defines a surface having a plurality of micro-protrusions projecting outwardly therefrom. A microedged-shaving element is carried by each of the protrusions. Each shaving element defines a peripheral edge having sharpness sufficient to cut into human hair. Preferably, the protrusions are each frusto-conical in shape and define an upper surface upon which each of the micro-edged shaving elements is supported. It is also preferable that each microedged shaving element be circular and have a sharpened periphery. To ensure the sharpness of the periphery, each shaving element is coated with a metallic layer, which in the preferred embodiment includes tungsten. This layer provides hardness sufficient to allow the cutting edges on each shaving element to be maintained.

[0009] An advantage of the present invention lies in the fact that the micro nature of the shaving elements causes then to be less likely to cut the skin of a user. In addition, handling of the shaving surfaces during manufacture is safer.

Brief Description of the Drawings

[0010] FIG. 1 is a partial, side elevational view of the microedged-shaving surface of the present invention.

[0011] FIG. 2 is a partial perspective view of the shaving surface of FIG. 1.

[0012] FIG. 3 is a flow chart schematically illustrating a method for producing the shaving surface of FIG. 1.

Detailed Description of the Preferred Embodiment

[0013] As shown in FIGS. 1 and 2, a microedged shaving surface, generally designated by the reference number 10 includes a substrate 12 made from a suitable material, such as, but not limited to silicon wafer material. A plurality of discrete shaving elements generally designated by the reference number 14 are attached to and project outwardly from a surface 16 defined by the substrate 12. Preferably the shaving elements 14 are formed from a suitable polymeric material, such as, but not limited to polyimide.

[0014] In the illustrated embodiment, each discrete shaving element 14 includes a generally frusto-conical support portion 18 attached to and projecting outwardly from the substrate surface 16. Each frusto-conical support portion 18 includes an outer surface 20 adapted to carry a microedged shaving portion 22 thereon. Each shaving portion defines a peripheral cutting edge 24 of sufficient sharpness to cut into human hair when drawn across a user's skin during a shaving operation. While the support portions 18 have been shown and described as being frusto-conical, the present invention is not limited in this regard as other configurations such as cylindrical or polygonal can be substituted. In addition, while the microedged shaving portions 22 have been shown in the illustrated embodiment as being circular, the present invention is not limited in this regard as other shapes, such as, but not limited to oval can also be employed without departing from the broader aspects of the present invention.

[0015] As schematically illustrated in FIG. 3, the shaving surface 10 can be produced by first providing a substrate 24. In the preferred embodiment of the present invention, the substrate can be a silicon wafer of the type used to produce semi-conductors, or the substrate can be a polymeric material, such as, but not limited to polyimide.

[0016] Where a silicon wafer is used as the substrate, the next step in producing the above-described shaving surface is to coat the substrate with polymeric material 26, preferably, but not limited to polyimide. A material found to be suitable for coating the substrate is Dupont® polyimide 2525. This material is applied by spinning six coats of the polyimide onto the substrate, each coat being approximately 8um thick. The material is allowed to cure and then six more coats each approximately 8um thick are applied and allowed to cure. Next, an edge layer of material 28 of sufficient hardness to support a cutting edge is applied over the polyimide. Preferably, this material is metallic. A material found to be particularly suitable for this application is tungsten sputtered onto the polyimide approximately 800A thick followed by 1500A of copper.

[0017] Subsequent to the application of the edge layer 28, the substrate is coated with a negative photoresistive material 30 which is exposed and developed to define areal portions thereof substantially impervious to removal by etching. These areal portions correspond to a pattern of discrete, individual, shaving elements. The negative resist is then processed to create a reentrant photo resist profile. The substrate with the above-described layers of different material thereon is then plated with nickel to provide a support layer to strengthen the whole shaving surface structure. Any remaining photoresist material is next stripped away 32 by dry or chemical etching. While a negative resist material has been shown and described, the present invention is not limited in this regard as a positive resist material may also be employed without departing from the broader aspects of the present invention.

[0018] The next step in the thus far described process is to etch the edge layer 34 by etching back the copper layer with a nitric acid (HNO3) solution down to the tungsten layer. Then the tungsten layer is etched through 36 by, reactive ion etching (RIE), down to the polyimide layer. The nickel layer is then wet etched leaving the tungsten layer intact to pull the nickel back from the peripheral edges of each shaving element to create a thin tungsten cutting edge. Finally the polyimide layer is etched though, using RIE, down to the substrate creating an undercut in the support portions 3818, FIGS. 1 and 2, so that the peripheral edges are exposed.

[0019] The microedged-shaving surface 10 can be mounted in any one of a number of different razor configurations. During operation, as the shaving surface 10 is drawn across the skin of a user, the microedged shaving portions contact hair protruding from the user's skin and successively cut into it until it is cut through.

[0020] While preferred embodiments have been shown and described, one skilled in the pertinent art to which the present invention pertains will immediately recognize that various modifications and substitutions may be made. Accordingly, it is to be understood that the present invention has been described by way of example, and not by limitation.